

Acknowledgements

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THE WISCONSIN COASTAL MANAGEMENT PROGRAM, part of Wisconsin Department of Administration, and overseen by the WISCONSIN COASTAL MANAGEMENT COUNCIL, was established in 1978 to preserve, protect and manage the resources of the Lake Michigan and Lake Superior coastline for this and future generations.

The Project Team

This project required coordination and completion of several steps including map documentation, photo preparation, photo interpretation, digital area/linear measurement and data sheet preparation. The following students worked as a team to help complete this project.

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Assessing Coastal Development Along Wisconsin's Great Lakes Shoreline: 1978 - 1992

Coastal Management Program Contract No. 840005-501.15

INTRODUCTION

The Wisconsin Coastal Management Program mission includes developing an understanding of change along the state's Great Lakes shoreline. Such change, of course, can be natural or human-based. This study was undertaken to document natural and human-based development within the coastal zone of the state's Lake Michigan and Lake Superior shorelines. The Wisconsin legislature has defined coastal zone as land within 1,000' (304.8 meters) of the shoreline (Ordinary High Water Mark - OHWM).

Future coastal zone planning and risk assessment requirements defined the types of data to be collected. Assessment of risk to structures built in the coastal zone requires a temporal analysis of structural development and shoreline modification(s). Planning of the coastal zone requires, as well, determination of the natural resource base. This study utilized U.S. Army Corps of Engineers historic color aerial photographs taken in 1978 and 1992.

This report documents both the original and amended contract to assess natural and developmental change within the coastal zone of Wisconsin's Great Lakes shorelines. Although the original contracted work was interrupted to include elements of the amended contract, no attempt will be made in this report to keep separate original vs. amended objectives, procedures or results. Goals of the amended contract include and expand those of the original.

PROJECT GOALS

Planning and assessment of hazards within the coastal zone defined the goals of this study. Within the Lake Michigan and Superior coastal zones, project goals included:

- Development of land use databases for 1978 and 1992
- Development of 1978 and 1992 databases of human modification of the shorelines
- Develop a database of built structures for 1992 Additional goals included:
 - Assess land use change Within the coastal zone from 1978 to 1992
 - Assess human modification of the shoreline from 1978 to 1992

STUDY AREA

The project study area comprises the Wisconsin portion of the Lake Michigan and Lake Superior coastal zone (Figure 1). In 1982, the Wisconsin state legislature defined coastal zone as being that land within 1,000 feet (304.8 meters) of lake shoreline. Accordingly, the study area represents a 1,000' wide



Figure 1. Coastal Counties of Lake Michigan and Lake Superior

zone, the landward boundary of which is parallel to the coastline.

PROJECT METHODS

Aerial Photography

Using aerial photos to assess coastal development requires clear statement of goals, appropriate definition of coastal zone, meaningful classification scheme, appropriate historical and current aerial photos, appropriate interpretation procedure and method of documentation, and trained personnel.

Application of aerial photography to assess urban and natural resource features is documented well (Smith, 1968; Avery and Berlin, 1985; Lo and Noble, 1990; Ciciarelli, 1991; Boge et al., 1992; Hinckley and Walker, 1993). Specific applications to urban/human activities cover a wide range including urban nonpoint pollution assessment (Kim and Ventura, 1993), gully erosion analysis (Welch et al., 1985), historical analysis of urban development into coastal wetlands (Niedzwiedz and Batie, 1984), identifying structural additions to urban residential property (Niedzwiedz, 1990), and studying agricultural land use (Marsh et al., 1990).

Aerial photos have been used to map archeological sites, urban features, and to document changes to the landscape (Smith, 1968). MacConnell (1975) reports the use of black and white aerial photography (scale 1:20000) to map 20 years of land use change within the state of Massachusetts, including the coastal zone. As part of a larger Great Lakes study, the International Joint Commission (1993) used 1:24000 scale photos to map land use features along the Berrien County, Michigan segment of the Lake Michigan shoreline. Results of the photo analysis were used to assess residential riparian erosion/recession rates caused by fluctuating water levels.

Wisconsin's coastal zone includes diverse land use, from forests and wetlands, to land devoted to agricultural or urban uses. The uses of aerial photos long have been applied to study such land uses. Befort and Viliman (1985) studied aerial photos to classify forest habitat. McCarthy et al. (1982) evaluated spruce-fir forests to aid management. Wetlands analysis is possible with aerial photos of appropriate format, scale and seasonal timing. Scarpace et al. (1981) used digitized aerial photos to map wetlands, while Ferguson et al. (1993) and Barrett and Niering (1993) have monitored sawgrass habitat and marsh vegetation change using aerial photos.

Extensive use of aerial photography has been directed at coastal resources. Scherz and Van Domelsen (1973) used aerial photos to help assess water quality in Lake Superior near Duluth, Minnesota. Numerous studies have been made with aerial photos to aid management of coastal resources (Benton et al., 1978; Hill et al., 1985; Norton et al., 1985; Welch et al., 1992), to address change in coastal wetlands (Lyon and Greene, 1992), and to

examine urban development into coastal wetlands (Niedzwiedz and Batie, 1984).

Project Aerial Photos

In 1978, the U.S. Army Corps of Engineers (USACE) obtained panchromatic color aerial photos of the Wisconsin portion of the Lake Michigan coastline. In 1992, USACE obtained color aerial photo coverage of the Wisconsin portion of both Lake Superior and Lake Michigan coastlines. Both the 1978 and 1992 photos were flown at a scale of 1:6000 (1" = 500') and enlargements made at 1:2400 (1" = 200'). The 1978 photos were taken April 16th. The 1992 photos were flown May 13th.

Unlike most historical aerial photos covering the same area and flown at the same scale, the USACE photos of 1978 and 1992 were not flown with coincident photo centers or coverage. No individual flight lines were documented for the 1978 photos. Beginning at the Michigan border, the 1978 photos were taken incrementally to the Illinois border. Photos are documented with the photo date and photo number on the northern edge of each photo.

Flight lines were documented for the 1992 photos. Flight line #1 begins just south of the Wisconsin-Illinois border. The northern edge of each 1992 photo displays the photo date, flight line and photo number.

Both the 1978 and 1992 photo contact prints (1:6000) were flown to produce stereo coverage of the coastline. Adjacent photos overlap (endlap) about 60% with each other. The enlarged photos (1:2400) available for this study represent every other photo contact print, therefore, only photographic, not stereo coverage, is provided by the enlarged photos. Approximately 1,800 photos (1:2400) cover Wisconsin's Lake Michigan shoreline, 900 for each flight year. About 1,200 photos covering the shoreline from Marinette to Sheboygan are on file at the Green Bay office of USACE. The Waukesha office of USACE has on file about 600 photos covering the shoreline from Sheboygan to the Illinois border.

Photo Preparation

Photos used in this study are owned by USACE. As a result, all photo documentation and interpretive work was applied to acetate affixed to each photo. Preparing photos for interpretation included the following:

- 1. Affix label and document photo number/flight line, photo date and Public Land Survey System (PLSS) information.
- Mark photo fiducials (orange ink). Fiducials allow the registration of acetate overlays to the photos, if required.
- 3. Mark control points (orange ink). Typically these points are road intersections and, or buildings, stable objects

that could be referenced against controlled maps for future mapping applications.

- 4. Locate and mark interpretation boundary lines (black ink). These lines are used to denote a common boundary between adjacent photos. Land use interpretive lines end at these boundary lines, which eliminates redundant interpretive work.
- 5. Locate, mark and label PLSS section lines (red ink).
- 6. Locate, mark and label civil boundary lines (green ink).
- 7. Locate and mark 1,000' coastal zone boundary line (blue ink). A divider was used to scribe a line 1000' away and parallel to the line defined by land meeting water. In cases where large streams entered Lake Michigan, a straight dashed line was drawn to represent a continuation of the shoreline.
- 8. Locate and mark top of bluff, and bottom of bluff if slumpage is evident (black ink). In practice, these lines were not drawn until the shoreline portion of the classification scheme was applied to the photos. Refer to the section Photointerpretive Process (page 11) for additional discussion.

Aerial Photo Interpretation (API)

The landscape within the coastal zone can represent a complex mix of natural to urban uses. The land use classification scheme developed for this study addresses the complexity of Wisconsin's coastal zone. The scheme is a modification of the scheme developed by International Joint Commission (1993) and includes the general use categories of residential, commercial, industrial, transportation, extractive, agricultural, natural, open land and other uses. Land uses have been measured by area (acres, hectares). Structures per land use have been located and marked for spatial reference. Structures are tallied by type for 1992.

Modification of the shoreline also has resulted. Sea walls, revetments, groins and permanent docks have been constructed. Sea walls and revetments are linear types. Their interpretation and measurement are presented in feet (meters). Groins and docks were counted.

CLASSIFICATION SCHEME

Residential Land

All residential areas include infrastructure to service the area. Boundary placement is made to separate residential areas by type. No attempt is made to distinguish roads/streets from the residential areas they serve. This convention is true for other classification types as well.

- Multi-Family: Medium to High Rise. Large residential structure of five (5) or more stories. Access roads, parking areas, open space and recreational facilities associated with the structure(s) would be included in the type.
- 112 Multi-Family: Low Rise. Large residential structures up to four (4) stories. Access roads, parking areas, open space and recreational facilities associated with the structure(s) would be included in the type.
- 113 Single Family, Duplex. Structures large and small used for residential use. The type includes lawn, landscaped areas, garage and driveways. Duplex structures are identified by twin driveways or a very wide driveway leading to an architecturally balanced structure.
- 115 Mobile Home Park. Residential area developed exclusively for mobile units.

Commercial and Industrial Land

Commercial land includes three (3) types: central business district; shopping center/mall; and, neighborhood business district. Each type includes all building structures, access roads/streets, parking facilities and other features commonly associated with each type.

- 121 Central Business District (CBD). Commercial land predominantly used for distribution or merchandizing of goods and services. Stores, hotels, office buildings, parking facilities and smaller warehouses constitute the components of this type. The CBD spatially is tight, vegetation is rare.
- Shopping Center/Mall. These commercial areas have developed away from the CBD. The type includes both "strip" type development and malls. Structures can range from large, flat roofed and rectangular (centers) to large, geometrically shaped. Both types include large parking areas adjacent to or completely surrounding the commercial structures.
- Neighborhood Business District (NBD). This type denotes small commercial areas within, or adjacent to residential areas. The type may be found in established or newer subdivision areas. NBD structures can range from conventional architecture to unusual geometric shapes. Small parking areas are associated with NBD commercial areas.

126 Institutional Land. The type reflects areas devoted to public or quasi-public uses. Examples include schools, churches, hospitals, prisons, etc., and their associated "grounds," green space, landscaping and parking facilities. When located within the CBD, public buildings without "grounds" often cannot be identified on aerial photos and would be classified as commercial (121).

Industrial Land

138 Industrial Park. The type includes both heavy and light industrial use areas.

Heavy industrial land contains facilities for the manufacture, storage and assembly of raw or partially processed products such as machinery, metals, chemicals, petroleum, or electrical power. Such industries often have large smokestacks and large storage areas. Warehouses and transportation facilities for bulk products and an open and interrupted street pattern characterize this type.

Light industrial land contains facilities for the manufacture or assembly of smaller, partially processed products such as electronics, appliances, and other secondary process products. Large smokestacks or raw material storage facilities are never present. Many modern light industries are well landscaped and are indistinguishable from commercial activity on aerial photographs.

Transportation Land

- 141 Air Transportation. Includes areas with airports and associated facilities, landing strips, hangers, parking areas and adjacent open areas.
- 142 Rail Transportation. This type includes railyards, terminal freight and storage facilities as well as stations for passengers. The type may include liquid storage facilities such as tank farms.
- Water Transportation. This designation is applied to several water-based areas, including docks, warehouses and related land-based facilities for water transportation and commercial fishing. The type includes, as well, public marinas and their associated facilities: boat slips, buildings and parking areas.
- 143.1 Private Marina. Boat mooring areas adjacent to residential land are designated as private marinas. Often such areas include a protected slip(s), dredged waterway and, or a permanent docking structure built into the waterway.

- 143.2 Public Boat Landing. This type is applied to boat launching areas. Typically, facilities include only a ramp(s) from which boats may be launched and parking areas.
- 144 Divided Highway. This type includes transportation corridors with median strips between lanes. Typically, such roads are four or more lanes wide. Local streets are not included in this type.
- 145 Communications. Facilities and structures devoted to communications. These include radio/television towers, lighthouses and their grounds, buildings and parking areas.
- 146 Utilities. This type includes facilities for the production and distribution of energy. Such areas can include large buildings, towers, roads/parking facilities and, in the case of coal fired plants, large piles of raw coal.
- 147 Sewage Treatment Plant. Buildings, treatment lagoons, parking areas, access roads and grounds are included in this type.
- 148 Landfill. Landfill sites used to bury garbage define this type. Landfills cover an extensive area and are dominated by large excavated areas, mounds of exposed soil and access roads.

Extractive Land Use

- 171 Open Pit. The type represents open pit mining areas for extraction of sand, gravel, stone or rock. The type includes access roads and any structures.
- 172 Underground Mine. Mining of underground resources via shaft extraction. Surface features captured on aerial photos would be limited to small structures and access roads.
- 173 Well. Features associated with wells are limited. Identification of wells using only aerial photos is difficult.
- 179 Other Extractive Uses.

Agricultural and Natural Land

Abandoned Field (AF). These are agricultural units reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30%. If tree crown cover were greater than 30%, the land would be classified as forest.

- 182 Agriculture Active (AG). Tilled or tillable crop land which is or recently has been intensively farmed. The boundaries on the ground usually are sharply defined and well maintained. The land supporting farm buildings is included as part of this type.
- 183 Forest (F). Areas of forest, deciduous, coniferous or mixed, having canopy closure of at least 30%. Areas with less than 30% canopy closure are classified as abandoned field.
- 184 Heath (H). Areas of heath plant community as well as grass, shrubs, and other low vegetation found on poor sandy soils.
- Open Water (W). Areas of open water found in lakes, rivers and large streams. Water depth is greater than three feet during the growing season. The boundary of coastal water is located by drawing a line at the river mouth to connect the edges of the coastline, or man-made features like roads, railroads or bridges crossing rivers or inlets are used to establish such a line.
- 186 Rock Ledge (RL). Rock outcrop areas at the coastline or within the coastal zone. Such outcrops are common in Door County.
- 187 Slump Zone (SL). Land located between upland bluff and beach. Slump zones begin at the bluff line and slope down to the beach.
- 188 Wetland (WT). This type covers the full spectrum of wetlands. These include seasonally flooded flats, shrub swamps, meadows, bogs, shallow and deep marshes, and forested wetlands. Each is described below.

<u>Seasonally flooded basins or flats</u> occur principally on stream floodplains. The most common plants are grasses and herbaceous species. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season.

Shrub swamps often have waterlogged soil during the growing season, as much as six (6) inches of water may be present. Vegetation types include elder, buttonbush, dogwood and willow. Sedges usually are present in tussocks.

<u>Meadows</u> are vegetated with grasses, rushes and sedges. Soils are waterlogged through most of the growing season. Surface water is present only for a short period during the spring.

Bogs are unique wetland types that support a distinctive plant community, including most of the following: heath shrubs, cranberries, pitcher plants and sedges. Scattered black spruce, tamarack and red maple may be present. A mat of sphagnum moss is the most common feature of bogs.

<u>Shallow marsh</u> is wetter than meadow. The soil is completely waterlogged and often covered with up to six inches of water during the growing season. The predominant vegetation is emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead with some grasses and sedges present. The type is common to open water bodies.

<u>Deep marsh</u> has water depth ranging from six inches to three feet. Fairly large open water areas are bordered by or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweed, watershield and pondweeds also are present.

Forested Wetlands. This type represents areas of moist to saturated soil covered by forest canopy. The type is difficult to identify without stereo photography and, or with "leaves-on" photography.

Open and Other Land

- 191 Outdoor-Public Assembly
- 192 Urban Open Lots. Urban open is undeveloped land lying idle in the midst of urban areas or adjacent to them. This type includes land which has been cleared for urban development of an unknown use.
- Outdoor Recreation. Outdoor recreation types are either mainly for participation, mainly for spectators, or are environmental in character. Each recreational type includes the recreational complex: access roads, parking facilities, buildings and other related facilities.
- 194 Cemeteries

Shoreline Modification

Development along the lakeshore often means modification at, or near, the shoreline. Land along the lakeshore is exposed to significant erosional forces. Recession of land mass is common. Agricultural and urban land uses destabilize shoreland, in effect accelerating erosion and land recession. To protect real estate and property, many property owners have constructed walls or revetments along their shoreline. Some owners also have built non-flow-through docks at the shoreline to provide mooring and protection for their boats. Groins, large rock structures perpendicular to the shoreline, have been built along Wisconsin's Lake Michigan shoreline.

195 Sea Walls (\underline{V} 195 \underline{V}). These structures are built parallel to the shoreline and typically are well defined, linear

features. Construction materials can include concrete, wood or interlocking sheet steel.

- 196 Revetments (<u>V 196 V</u>). Large rock or slab structures built parallel to the shoreline. Interpretively, revetments are less well defined, and appear wider than do sea walls.
- 197 Groins (* [red]). Groins are large rock structures built perpendicular to the shoreline into the water. Except for their distinct orientation and placement, groins appear similar to revetments.
- 198 Non-Flow-Through Dock (* [blue]). Such docks are permanent structures built into near-shore waters.

 Typically these docks are straight, their upper surface wide and well defined.

Structures - Industrial, Commercial and Residential

On the 1992 photos, buildings within the coastal zone are classified by type and location. Using a template of rectangles, for each building, a rectangle is selected that best represents the area of the building's "footprint." The selected rectangle then is positioned so that the leading edge of the building (relative to the shoreline) is located. Buildings for 1978 were counted by type. However, due to photo format differences, comparison of 1978 and 1992 structural counts may be inaccurate.

THE PHOTOINTERPRETIVE PROCESS

After photo preparation, each photo was interpreted using the classification scheme defined above. Area (land uses), linear (shoreline modification) and point (urban structures, groins, docks) types are represented in this study. Lines and, or symbols were used to define all types. Area types are represented by perimeter boundary lines and symbols to define and identify the areas. Line types representing modification to natural shoreline were defined using both lines and symbols. All area and line type symbols are recorded in black ink. Point types are defined by symbols and colored ink (see above).

Modifications to the shoreline, such as sea walls or revetments, are delineated by placing (painting) the 'V' symbol at the beginning and end of the modification. The type of modification is represented by placing the appropriate number between the 'V' symbols. For example, 195 positioned between two 'V' symbols means that a sea wall has been built along this section of shoreline. Shoreline classification was conducted before land use so that land use boundary lines placed along the shoreline would not 'hide' shoreline information.

Groins and non-flow-through docks were defined by point symbols (see above). In both cases, the symbol was placed at the point where the structure meets land. As discussed above, for

1992, buildings also were classified using point symbols. The delineation of buildings represents the last API procedure.

MEASUREMENT OF AREA, LINE AND POINT TYPES LOCATED WITHIN THE COASTAL ZONE

Area types (land use polygons) and line types (shoreline modification) measurements were made using the hardware/software facilities of the GIS Lab at the University of Wisconsin-Green Bay. Photo acetate overlays were affixed to large-format digitizers and each land use polygon digitized along the perimeter. Measurements recorded in square inches were converted to acres/hectares. Line measurements (in inches) of shoreline modifications were made using digitizers as well. Linear inch measurements were converted to linear feet/meters for each type of modification.

Point types (groins, structures) simply were tallied by count for each type. The area covered by each acetate was broken into civil jurisdiction and PLSS section designations.

Measurements (above) were separated by civil and PLSS designations as well, and documented permanently on each acetate overlay.

TALLY OF DATA

Measurements recorded on each photo acetate were transferred to data sheets. Three (3) levels of data sheets were used: PLSS Section Data; Civil Jurisdiction Summary Data; and County Summary Data (Appendix).

<u>PLSS Section Data Sheet</u>: One (1) PLSS Section Data sheet was used for each section located on a photo/acetate. Generally, 1-2 PLSS sections are located on a photo, however, up to four (4) sections per photo were recorded. Section level data sheets record photo documentation including photo year, photo number, county and community(ies) covered, and complete PLSS section location. Also recorded were number of residential, commercial, industrial and institutional structures (1992), area of land use by type, linear distance of sea walls and revetments, and the number of groins and non-flow-through docks.

Civil Jurisdiction Summary Data Sheet: This tally sheet summarizes the data for all PLSS section sheets found within each township, village or city. The sheet records photo year, county, name of civil jurisdiction, a complete listing of PLSS sections included in the summary, as well as all land use, shoreline and structure count data discussed above.

County Summary Data Sheet: The County Summary sheet summarizes all data for the towns, villages and cities located within the county. Documented information includes photo year, county name, an alphabetical listing of all civil jurisdictions within the county, and a summary of all land use, shoreline and

structure count data reported on Civil Jurisdiction Summary Data sheets.

LIMITATIONS AND SOURCES OF ERROR

The U.S. Army Corps of Engineers contracted for aerial photography of the Wisconsin portion of the Lake Michigan shoreline on April 21, 1978 and May 19, 1992. Both sets of photos are 1:6000 scale and panchromatic color, however, the 1978 photos are "leaves-off" while the 1992 photos are "leaves-on."

Copies of the original stereo photos (1:6000 scale) were not available for this study. Instead, enlargements (1:2400 scale) of the original photos were borrowed from Corps district offices in Green Bay and Waukesha. The enlargements provided photographic coverage only, not stereo coverage. Normally, for a project of this magnitude, photos would have been taken to meet the specific objectives of the study. The enlarged photos used for this project present limitations and introduce error beyond what would be reported with original photos flown specifically for this study. Limitations and errors associated with the photographs used are discussed below. Also presented below is discussion regarding methodological inconsistencies.

The following discussion of Limitations and Sources of Error is presented in an attempt to provide the reader a basic understanding of the issues. Any section of the discussion could apply to any of the results reported below. The Results sections of this report present findings without any comprehensive attempt to explain anomalies within, or between, the photo study years (1978 and 1992).

Photo Scale and Enlargements

All vertical aerial photographs not ratioed (enlarged or reduced to a common average scale) or rectified (common tilt/tip corrected to a horizontal reference plane) inherently are scale inaccurate. The original USACE photos (1978 and 1992) were not ratioed or rectified, therefore, their scale varies relative to topographic changes of the coastal zone, tip/tilt of the camera and changing elevation of the camera (aircraft). Enlargements of the original photos simply accentuate the inaccuracies found on the original photos.

Area and linear measurements taken off of the USACE enlarged photos reflect the inaccuracies inherent in those photos. Simple tests of shoreline distances for numerous PLSS sections within each county were conducted to establish linear accuracies of the photos. USGS topo sheets at 1:24000 scale were used to establish base shoreline distance measurements against which photo (1978 and 1992) shoreline distance measurements could be compared. No systematic errors were detected for the 1978 photos. However, only one (1) of 21 tests of the 1992 photos varied in the positive direction from USGS measurements. The remaining 20 tests varied in the negative direction and ranged from -0.8% to

-13.1%. The range of error, for 1978 was -5.3% to +9.6%, while the range of error for 1992 was -13.1% to +1.9% (see Table 2 page 18). Without a test of error for each photo used, there is no means to judge the direction or the amount of error relative to statistics associated with each photo. However, given the range of error found for the 1978 and 1992 photos, it is possible that 1,000 acres (405 ha) (actual) of coastal zone area could be reported as 1,096 acres (444 ha) in 1978 and 869 acres (352 ha) in 1992, a 227 acre (92 ha) difference.

"Leaves-On" Versus "Leaves-Off" Aerial Photography

There are distinct advantages and disadvantages of both "leaves-on" and "leaves-off" aerial photography. However, given the goals of this project, the 1978 "leaves-off" photography offers important advantages over the 1992 "leaves-on" photography. Vegetation in leaf can hide the details of built structures, including buildings and shoreline modifications. Roads can be hidden under tree crowns, as well as portions of lots landscaped and managed as residential land. Leaved canopies increase the effect of shadows. Shadows mask ground, understory and structural information leading to inaccurate interpretation. Land uses and/or structures hidden under the canopy of vegetation or masked by shadows can be underestimated in area, length or count. Land use types particularly affected (underestimated) are single family residential and wetland.

Stereo Versus Photographic Coverage

Both the 1978 and 1992 photo sets were taken to capture stereo (3-D) coverage of the Lake Michigan coastal area. This means that adjacent photos overlap approximately 60%. Stated another way, 60% of the shoreland area located on one photo also is located on an adjacent photo. The shoreland common to adjacent photos is "seen" from two different perspectives which allows stereo viewing (using a stereoscope).

The enlarged photos borrowed from USACE for this study represent photographic coverage only, or every other photo taken of shoreland. While photo (2-D) coverage at large scales can be used to interpret accurately many land use types (agricultural and most urban land), the lack of stereo viewing makes difficult the identification of wetland types and the exact location of bluff lines. Stereo viewing generally would have increased the interpretive accuracy of most land use, structural and shoreline features.

Incomplete Photo Coverage

For this study, the coastal zone is defined as a 1000' strip of land adjacent and parallel to the shoreline. Occasionally, photo coverage did not include all shoreland within 1000' of the water. As a result, total land area is underrepresented, the

exact land use types not covered are not known. In such cases, the area not captured on a particular photo was estimated by reference and comparison to coverage photos of the other flight year.

Missing Photo Coverage

Occasionally, photo coverage was missing from the USACE photo library. In such cases, as described above, coverage area missing was estimated by reference to photos of the other flight year. However, the exact land use types and shoreline features not represented on photos remain unknown.

Location of 1000' Coastal Zone Boundary

On each photo set, 1978 and 1992, a boundary line was drawn representing the 1000' coastal zone parallel to the shoreline. This line was located by scribing a landward line parallel to the line defined by the shoreline (where water meets land). The landward extent of the boundary line is a function of shoreline location, which in turn, is dependent on the water elevation of Lake Michigan. USACE (1978, 1992) reports that in April of 1978 Lake Michigan water elevation was about 578.4 feet (176.3 meters) and about 579.16 feet (176.5 meters) in May, 1992. The nine (9) inch difference in water elevation, while seemingly insignificant, could have shifted substantially landward the shoreline in extremely low slope beach or mud flat areas. The result of such a shift would be inclusion of inland areas NOT included in the 1978 coastal zone.

Lack of Beach Type in Classification Scheme

The width or extent of beach is dependent on slope of an area and water elevation. Since changes in the area of beach likely would reflect more the differences in 1978 and 1992 water levels (9 inches higher in 1992) than actual losses/gains due to erosion or development, no beach type was included in the study.

The lack of a beach type does affect measurement of area within the 1000' coastal zone. The landward extent of the coastal zone is 1000' from the <u>shoreline</u>. Any beach area lies between the shoreline and the base of the bluff, however area measurements of land use types were made only for those types lying between the base of the bluff and the interior boundary of the coastal zone. In most cases, beach strips represent only about five (5) acres per photo.

Positional Changes to the Shoreline: Natural vs. Urban Development

As discussed above, the landward extent of the 1000' coastal boundary is dependent on the location of the shoreline. Natural changes to shoreline position include both water elevation and

erosion/deposition of soil. Filling of coastal waters to accommodate urban development artificially changes shoreline In such cases, not only does the shoreline move "offshore," the interior coastal zone boundary line shifts toward This "shift" in coastal boundaries skews area the water. measurement. For example, in 1978 assume the coastal zone in an area to be all residential and that by 1992 100 acres of lake water is filled to develop commercial land. A "lakeward" shift in the location of the shoreline will occur due to the land filled for commercial use. However, this "shift" in the shoreline created by the filled commercial site also will resulauin a shift toward the water of the interior coastal zone The effect of the latter shift will be that 100 acres boundary. of residential land will not be included as part of the 1992 coastal zone. In such a case, the "raw' statistics misleadingly suggest that 100 acres of residential land use were eliminated to make room for 100 acres of commercial use.

RESULTS

Brown County Statistics

Brown County communities lying within the Lake Michigan coastal zone include the townships of Green Bay, Scott and Suamico, the village of Howard and the city of Green Bay. The area measured within the coastal zone of Brown County was 3,647 acres (1,476 ha) in 1978 and 3,408 acres (1,380 ha) in 1992. This represents a difference of 239 acres (97 ha) or 6.5%. The discrepancy likely is the result of errors inherent in the enlarged aerial photos, as discussed on pages 12 through 15. Summary statistics of land use distribution within the coastal zone of each community are presented in Table 1.

Using USGS maps as control, tests were conducted on the linear accuracy of the enlarged Brown County photos. Results of tests applied to the 1978 photos indicate virtual agreement (less than ½ of 1% error) with USGS measurements. However, results of tests applied to the 1992 photos indicate errors of -5.5% to -8.5% (Table 2), or a shortage of up to 310 acres (126 ha).

Statistical summaries for Brown County and all communities included in this study are located in Appendix. Summary data sheets present land use types by area, 1992 structural counts by type, shoreline modification types by length, and a count of shoreline structures by type. Data were collected at the PLSS section level. The section level data sheets are not included in this report.

¹Area figures used in the Results discussion reflect totals (not rounded) reported on the original tally sheets. Figures presented on the tally sheets found in the Appendix of this report have been rounded to the nearest whole number.

Table 1. County Coastal Zone Area by Community, Year and Land Use Type (acres [hectares])

	Total Coastal Zone Area	Residen- tial	Commer- cial	Idus- trial	Transpor tation	Extrac- tive	Agricul- ture/ Natural	Open/ Other
County 1978	3647	598			309	:	2323	317
1992	(1476) 3408 (1380)	(242) 557 (225)	(16) 39 (16)	(24) 52 (21)	(125) 265 (107)	•	(940) 2105 (850)	(128) 390 (158)
City of 1978	Green Bay	244	28		295	•	275	244
1992	(464) 1081 (437)	(99) 228 (92)	(11) 33 (13)	(24) 42 (17)	(120) 254 (102)	;	(111) 216 (87)	(99) 309 (125)
Town of 1978	Green Bay 394 (159)	83		: : : : : : : : : : : : : : : : : : : :		•	242	58 (24)
1992	365 (148)	(35) (35)	(3)	:	(5) (<1)	;	(55) 210 (85)	(25) (25)
Village 1978	of Howard 386	27	:::::::::::::::::::::::::::::::::::::::	•	:		352	
1992	(158) 391 (158)	(11) 29 (12)	1	1	1	!	(143) 352 (143)	(4)
Town of 1978	Scott	151		: :	: 1	•	571	• •
1992	(296) 773 (313)	(61) 145 (59)	(2)	6 (2)	<1 (<1)	!	(231) 616 (249)	(2) (3)

Table 2. County Results of Linear Accuracy Tests

Percent Deviation From USGS Base Map Measurements

County	1978 Enlarged Photos (1:2400)	1992 Enlarged Photos (1:2400)
Brown	-0.4% 0.03%	-8.5% -5.5%
Door	1.3% 3.9%	-1.1% -3.6%
Kenosha	-2.5% 3.1%	-9.0% -1.6%
Kewaunee	-1.5% 2.1%	-5.4% -9.6%
Manitowoc	-1.7% 2.0%	-6.4% -7.4%
Marinette (one test)	9.6%	-1.7%
Milwaukee	-4.9% -5.3%	-6.9% 1.9%
Oconto	2.9% 8.5%	-10.8% -13.1%
Ozaukee	0.2% 1.3%	-5.7% -4.4%
Racine	-3.0% 2.2%	-5.0% -0.8%
Sheboygan	-2.5% 4.6%	-1.2% -3.0%
Mean	0.95%	 -5.18%
Range	-5.3% to 9.6%	-13.1% to 1.9%

Residential Land

Within the coastal zone of Brown County over 1,600 residential structures were identified on 557 acres (225 ha) of land. Total structures included 1,007 single family or duplex units, 308 detached garages, 279 sheds and 13 barns. Since the 1992 photos are "leaves-on," these numbers likely underestimate the actual number of structures and area devoted to residential uses. In 1978, 598 acres (242 ha) of residential land was measured. The "loss" of 41 acres (16.6 ha) of residential land probably is the result of photo scale and interpretive misclassification caused by "leaves-on" photos.

Commercial and Industrial Land

Commercial land represented 39 acres (16 ha) for both 1978 and 1992. Nineteen (19) commercial structures were noted within the coastal zone of 1992. Industrial land covered 60 acres (24 ha) and 52 acres (21 ha) in 1978 and 1992, respectively. Photo scale could account for the reported eight (8) acre loss. However, the industrial type includes "grounds" used for outside storage and movement of materials, which, given the nature of the Bay Port Industrial Park, could have changed dramatically during the 14 year period.

Transportation Land

Twenty-five (25) structures were located on 265 acres (107 ha) of transportation land in 1992. In 1978, 309 acres (125 ha) of transportation land were reported, a reduction of 44 acres (17.8 ha) compared to 1992. The transportation category contains the landfill type which declined in area from 222 acres (90 ha) in 1978 to 179 acres (73 ha) in 1992. Such a decline reflects the dynamic nature of landfill development and use, and as reported, accounts for the loss of transportation land over the period studied.

About seven (7) acres (2.8 ha) of marina land were developed between 1978 and 1992.

Agricultural and Natural Land

Overall, 218 acres (88 ha) of agricultural and natural lands were reported lost from 1978 to 1992, a trend that continues - nationally. Land actively being cultivated declined by 71 acres (29 ha) or by 12.5%. Both abandoned fields and forest lands increased in area by 130 (53 ha) and 166 acres (67 ha), respectively. While such a trend would be expected, given farmland abandonment, the magnitude of these increases reflects as well, the impact of the 1992 "leaves-on" photography.

Of particular note is a 414 acre (168 ha) decline of wetland types. The loss can be attributed to both urban development and the nine (9) inch rise in Lake Michigan water level. Due to

higher water, Suamico alone lost about 200 acres (81 ha) of wetland. However, a portion of the loss could be attributed to the underestimation of wetlands while using "leaves-on" photos.

Shoreline Modifications

Sea walls and revetments are used to protect shorelines from erosion. Significant increases of both types of structures were observed. In 1978, 18,350 feet (5,595 m) of sea wall were reported compared to 19,578 feet (5,969 m) in 1992, representing an increase of 1,228 feet (497 m) or 6.7%. However, far more significant is the 10,069 foot (4,078 m), 23% increase in revetment development since 1978. Shoreline revetment was measured at 43,598 feet (13,292 m) in 1978 and 53,677 feet (16,365 m) in 1992.

Results by Community

City of Green Bay

Land within Green Bay's coastal zone was measured at 1,146 acres (464 ha) in 1978 and 1,081 acres (438 ha) in 1992. The difference of 65 acres (26 ha) represents 5.7%. The source of the difference could be photo scale anomalies as discussed above. However, the difference also might be explained in the landward shift in shoreline location in 1992 due to increased lake level.

In 1992, 562 residential structures were located on 228 acres (92 ha) of land. Most of these structures (382) were single family or duplex. Other structures associated with residential uses included 108 detached garages, 66 sheds and 1 barn. In 1978, 244 acres (99 ha) of residential was reported, 16 acres (6.5 ha) more than reported in 1992. Reasons for such a reduction are discussed above.

Commercial area remained stable over the study period, the most significant change being a 3.7 acre (1.5 ha) increase in business district. Results indicate that industrial park land decreased by 18 acres (7.3 ha), however, the decrease is more likely to be the result of aesthetic changes of the Bay Port Industrial Park than actual losses of the industrial type.

The transportation category, too, appears to have lost area from 1978 to 1992, 295 acres (120 ha) and 254 (102 ha), respectively. Eighteen (18) structures were counted, most falling in the types sewage treatment (7), utilities (7), or marina (4). Significant changes occurred within the marina and landfill types. From 1978 to 1992, marinas increased by 8.2 acres (3.3 ha) or nearly 104%. Landfill area decreased by 43 acres (17 ha) or 19%.

Agricultural and natural areas decreased from 275 acres (111 ha) in 1978 to 216 acres (87 ha) in 1992. Active agricultural land declined by 27 acres (11 ha) or 18% while forest land increased by 18.6 acres (7.5 ha) or 326%.

Wetlands lost the most area of any type within the natural lands category, from 75 acres (30 ha) in 1978 to 21 acres (8.6 ha) in 1992. The loss of 54 acres (22 ha) represents 72%.

Two open/other land types showed significant change during the period studied. Urban open lot areas decreased from 38 acres (15.4 ha) in 1978 to 22 acres (8.8 ha) in 1992, suggesting the process of infilling is occurring along near-shore lots. The outdoor recreation type increased from 206 acres (84 ha) in 1978 to 283 acres (115 ha) in 1992. Most of this land is related to the University of Wisconsin-Green Bay campus and surrounding Cofrin Arboretum.

From 1978-1992, significant shoreline modification has occurred within the city. Sea wall construction increased by 1,483 feet (451 m) or 54%, from 2,728 feet (832 m) to 4,211 feet (1,284 m). Likewise, revetment construction increased from 18,392 feet (5,607 m) to 32,202 feet (9,818 m), an increase of 13,810 feet (4,210 m) or 75%.

Town of Green Bay

Coastal zone area within the township was measured at 394 acres (195 ha) in 1978 and 365 acres (148 ha) in 1992, a difference of 29 acres (11.7 ha). The town of Green Bay was one of those tested for linear accuracy of photo coverage. Using USGS maps at 1:24000, measurements taken from the 1978 photos fell within +.03% of the USGS basis. The 1992 photos deviated by -5.5% from the USGS basis.

In 1992, a total of 303 residential structures were identified on 86 acres (35 ha) of residential land. Of these, 177 were of the single family/duplex type. Other structures associated with residential use included 55 detached garages, 66 sheds and five (5) barns.

In 1992, eleven (11) commercial structures, including two (2) institutional buildings, were located on 6.6 acres (2.7 ha) of commercial land. The total area represents a modest increase over 1978. No industrial land was identified for either study year.

Agricultural and natural areas decreased from 242 acres (98 ha) to 210 acres (85 ha) for the period studied. Changes within the category include a 22 acre (9 ha) increase in abandoned field, a 16 acre (6.6 ha) decrease in active agricultural fields, and a 30 acre (12 ha) decrease in forest land.

Results indicate losses of 301 feet (92 m) and 332 feet (101 m) of sea wall and revetment, respectively. These results likely represent masking by leaves and shadows rather than actual losses of shoreline structures. By 1992, one (1) groin had been built in the township.

Village of Howard

In 1978, a total of 386 acres (156 ha) comprised the coastal zone of Howard. In 1992, 391 acres (158 ha) were located within the coastal zone.

Residential land encompassed only 29 acres (11.6 ha) in 1992, which represents but a modest increase over the 1978 residential area of 27 acres (11 ha). Seventy-one (71) structures, of which 39 were single family/duplex, were located within the 1992 coastal zone. Other structures related to residential uses included 10 detached garages and 22 sheds.

For both study years, over 90% of the coastal zone fell into agricultural and natural land use types. A total of 352 acres (143 ha) were reported within this category for each study year. Within these types, forest land increased by 42 acres (17 ha) while wetlands decreased by 34 acres (14 ha).

Shoreline modifications increased by 175% (656 feet [200 m]) during the 14 year period studied. Sea walls decreased from 219 feet (67 m) to 34 feet (10.4 m) during the period, however revetment construction increased considerably, from 156 feet (48 m) to 996 feet (304 m).

Town of Scott

The coastal zone for the town of Scott was determined to cover 732 acres (296 ha) in 1978 and 773 acres (313 ha) in 1992. The 41 acre (17 ha) difference is 5.6% of the 1978 total. The town of Scott was one of the sites tested to determine linear accuracy of the enlarged photos. The 1978 photos of Scott were determined to be within $\frac{1}{2}$ of 1% of measurements taken from USGS 1:24000 maps. However, the 1992 photo measurements deviated from the USGS maps by 8.5%.

The amount of residential land located within the coastal zone remained stable from 1978 to 1992 at about 145 acres (59 ha). Within the residential area were counted 435 structures, 264 of which were identified as single family/duplex. Other structures associated with residential use included 90 detached garages, 76 sheds and five (5) barns.

Commercial land accounted of 5.3 acres (2.1 ha) of the coastal zone in 1978. No commercial land was evident in 1992. While no industrial land was identified in 1978, 5.6 acres (2.3 ha) were identified in 1992.

No extractive uses were observed for either study year. The town of Scott was the only Brown County community to show an increase in total agricultural and natural lands, from 571 acres (231 ha) in 1978 to 616 acres (249 ha) in 1992. The type abandoned field increased from 4.3 acres (1.7 ha) to 84 acres (34 ha) as did forest land, from 68 acres (27 ha) to 173 acres (70 ha). However, other important land uses experienced declines that parallel national trends. For example, active agricultural lands declined by 20 acres (8 ha) or 7.1%, and wetland area declined by 114 acres (46 ha) or 64%.

Structural modification of the shoreline to protect coastal property increased by 588 feet (179 m) or 50% from 1978 to 1992. Sea wall construction increased from 5,108 feet (1,557 m) to 6,197 feet (1,889 m). However, revetment construction appears to have decreased from 6,428 feet (1,960 m) to 5,527 feet (1,807 m). The decline in revetment construction is suspect and may reflect interpretive difficulties associated with the 1992 "leaves-on" photos.

Town of Suamico

Total coastal zone within the town of Suamico was measured at 988 acres (400 ha) in 1978 and 797 acres (323 ha) in 1992, a difference of 191 acres (77 ha) or 19.3%. The difference is the result of change of lake elevation between 1978 and 1992. Lake Michigan in 1972 was nine (9) inches deeper than in 1978. As a result, Suamico lost about 200 acres (81 ha) of wetland. About 100 acres (41 ha) of the loss occurred along Little Tail Point, with remaining losses occurring along the mainland shoreline and the section of Long Tail Point covered by aerial photos.

Results indicate that land used for residential purposes declined from 93 acres (38 ha) in 1978 to 69 acres (28 ha) in 1992, a loss of 24 acres (9.7 ha). Analysis of the aerial photos suggests three factors contributing to the lost area. In a few cases, residential land was abandoned and structures removed. The 1992 photos captured land cover conditions when vegetation was in leaf and when lake and ground water levels were higher than in 1978. Careful analysis of both photo sets indicates that leaved vegetation did "hide" photographic evidence of residential use of land, especially lawn areas. The analysis yielded another interesting finding, that the combination of Suamico's low-lying coastal land and higher water levels resulted in soggier soils. The photo evidence suggests that some residential areas managed as lawn in 1978 were too wet to do so in 1992. Photo interpreters use lawn management evidence to aid placement of residential boundary lines.

In 1992, a total of 241 structures were identified on the 69 acres (28 ha) of residential land. These structures included 145 single family/duplex units, 45 detached garages, 49 sheds and two (2) barns.

No commercial land was observed within the town's coastal zone for either study year. In 1978, no industrial land was recorded compared to 4.1 acres (1.7 ha) in 1992.

Land uses falling under the transportation category remained stable at about 9.5 acres (3.8 ha) for each year. No extractive land use types were documented for either study year.

Agricultural and natural land uses represented about 90% of total coastal zone area for both 1978 and 1992. In 1978, 882 acres (357 ha) of agricultural and natural land were recorded compared to 711 acres (288 ha) in 1992. The loss of 171 acres (69 ha) represents 19.4%. While the type abandoned field increased by 16 acres (6.5 ha), active agricultural land

decreased by 6.2 acres (2.5 ha). Forest land increased 31 acres (12.6 ha) or by 126%. Wetlands, as explained above, lost considerable area due to higher water levels. Wetland area declined from 761 acres (308 ha) in 1978 to 557 acres (226 ha) in 1992.

No change in open/other land was observed.

In 1978, 2,794 feet (852 m) of sea wall were recorded compared to 2,413 feet (736 m) in 1992, a loss of 381 feet (116 m). Revetments declined from 16,892 feet (5,150 m) in 1978 to 14,337 feet (4,371 m) in 1992.

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APPENDIX

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

County Summary Data Sheet

Year: 1978

County: Brown

Coastal Civil Jurisdiction included in summary (in alphabetical

order).

City of Green Bay
Town of Green Bay
Village of Howard
Town of Scott
Town of Suamico

LAND USE CATEGORIES

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		# of structur		<u> Hectares</u>	
		•	our activities of the		
11 Residential	ر د د پیمود سد و فواو پر کافت	- Banker - Brown - In	e de la companya de La companya de la companya de l		
111 Res. units	·		e transfer of		
garages -					
sheds	·				
112 Res. units	•	3	2	1	
garages	······································				
sheds 113 Res. units	•	1026	597	242	
garages		355	391		
sheds		388			
barns		41			
115 Res. units					
garages					
sheds					
	Subtotal	1813	598	242	
12 Commondal					
12 Commercial	•		•		
121 Central Bus	iness Dist	9	6	2	
122 Shopping Ce			1	1	
124 Neighborhoo	d Business I	Dist <u>12</u>	8	3	
126 Institution	al	6	24	10	
	Subtotal	27	39	16	
The Control of the Co	on comment and a	e engles e la company		• •	
13 Industrial	edde Cale Cale Cale Cale Cale Cale Cale Cal	and the second s		:	
138 Industrial	Park	23	60	24	
				47	

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

County Summary Data Sheet

Year: 1992 County: Brown

Coastal Civil Jurisdiction included in summary (in alphabetical

order).

City of Green Bay Town of Green Bay Village of Howard Town of Scott Town of Suamico

LAND USE CATEGORIES

			Ar	ea
		# of structures	Acres	<u> Hectares</u>
11 Residential				
111 Res. units				
garages sheds				
112 Res. units garages sheds		5	2	1
113 Res. units		1007	555	225
garages		308		
sheds	·	279		
barns		13		
115 Res. units garages				
sheds	Subtotal	1612	557	225
12 Commercial				
121 Central Bus	iness Dist	6	4	2
122 Shopping Ce				
124 Neighborhoo	d Business	Dist <u>11</u>	9	44
126 Institution		2	26	11
	Subtotal	19	39	16
13 Industrial				
138 Industrial	Park	21	52	21

Civil Jurisdiction Summary Data Sheet

Year: 1978

County: Brown Township, Village PLSS section data		e: City of Green		11
description):	<u> </u>	·	, 1.0 10.	•
SE	C 13 C 14 C 24 C 25	T24N R21E SEC 11 SEC 12 SEC 13 SEC 14		SEC 27 SEC 28 SEC 29
· -	C 45	SEC 14 SEC 22		SEC 45 SEC 46
	C 46	SEC 23		SEC 40
	•			
en e	LAND U	SE CATEGORIES		
man and the second of the seco			•	
		,	_	rea
	j	f of structures	Acres	Hectares
11 Residential		sem in the second of the secon		
111 Res. units	* ***	4. White of the Professional Section 1999		
- garages				
sheds				
112 Res. units		3	2	1
garages				
sheds				
113 Res. units		359	242	98
garages sheds		130 92	·	
barns	•	19		
115 Res. units		***************************************		
garages				
sheds		_		
** ** · · ·	Subtotal	603	244	99
12 Commercial				
121 Central Bus	iness Dist _			
122 Shopping Ce				
124 Neighborhoo			4	2
126 Institution		6	24	10
in the second of	Subtotal	9	28	11
13 Industrial		r manaziria (m. 1900). Manaziria (m. 1900).		•
138 Industrial	Park	23	60	24

		Area	3
	# of structur	es Acres	<u> Hectare</u>
14 Transportation			
141 Air Transportation	·		
142 Rail Transportation			
143 Water Transportation			
143.1 Private Marina		1	<1
143.2 Public Boat Landing _			3
144 Highways 145 Communications		4	2
145 Communications		<u> </u>	
146 Utilities	4	41	16
147 Sewage Treatment Plant	2	21	8
148 Landfill		222	90
Subtotal	9	295	120
17 Extractive			
171 Open Pit			
172 Underground			· · · · · · · · · · · · · · · · · · ·
179 Other Extractive	·····		
Subtot	al		
The second secon	•		
18 Agricultural and Natural			
181 AF Abandoned Field		19	8
182 AG Agriculture Active			61
183 F Forest		6	2
184 H Heath			
185 OW Open Water		26	10
186 RL Rock Ledge	. 		
187 SL Slump Zone			
188 WT Wetland		75	30
Subtotal	:	275	111
Company of the Compan		٠	
19 Open Land, Other			
of the content of the			
191 Outdoor-Public Assembly	/ 		
192 Urban Open Lots	1	38	15
193 Outdoor Recreation	16	206	84
194 Cemeteries	17	244	99
	- ·		
		Total Acres	1146
		Total Hectares	s 464
Shoreline Modifications		Line	
400 0		<u>Feet</u>	<u>Meter</u>
195 Sea Walls		2728	832
196 Revetments		18392	5607
197 Groins		# of Groins	_1
198 Dock Non-Flow-Through _		# of Docks	1

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Brown

Township, Village or City name: City of Green Bay PLSS section data sheets <u>included in summary</u> (give full

description):

T24N R20E	SEC	13	T24N	R21E	SEC	11	SEC	27
•	SEC	14			SEC	12	SEC	28
•	SEC	24			SEC	13	SEC	29
					SEC	14	SEC	45
					SEC	22	SEC	46
					SEC	23		

LAND USE CATEGORIES

:	j	f of structures	Ar <u>Acres</u>	rea <u>Hectares</u>
11 Residential	•			
111 Res. units garages sheds				
112 Res. units garages sheds		5	2	1
113 Res. units garages sheds		382 108 66	227	92
barns 115 Res. units garages		1		
sheds	Subtotal	562	228	92
12 Commercial				
121 Central Bus 122 Shopping Cer	nter/Mall			
124 Neighborhood		ist <u>8</u>	7	3
126 Institution			25	10
13 Industrial	Subtotal	8	33	13
To THUMBEL THE				
138 Industrial 1	Park	10	42	17

4 Transportation	# or scructure	es <u>Acres</u>	nectare
4 Transportation			
141 Air Transportation			
142 Rail Transportation _		1	1
143 Water Transportation			
143 Water Transportation _ 143.1 Private Marina	4	14	6
143.2 Public Boat Landing		2	1
144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant		2	1
145 Communications			
146 Utilities	7	34	14
147 Sewage Treatment Plant		21	9
148 Landfill	·	179	73
Subtotal	18	254	102
7 Extractive			
171 Open Pit		•	
172 Underground			
470 17-11			
179 Other Extractive			
Subto			
Subco	Cai		
8 Agricultural and Natural			
181 AF Abandoned Field		29	12
182 AG Agriculture Active			50
183 F Forest		24	10
184 H Heath		<1	<1
185 OW Open Water		19	8
186 RL Rock Ledge			
187 SL Slump Zone			
188 WT Wetland		21	9
Subtotal		216	87
Open Land, Other			
191 Outdoor-Public Assembl	_v	4	1
192 Urban Open Lots	_	22	9
193 Outdoor Recreation	16	283	115
194 Cemeteries			<u></u>
Subtotal	16	309	125
		Total Acres	1081
		Total Hectares	437
noreline Modifications		Linea	
		Feet	Meter
		4211	1284
		32202	9818
197 Groins		# of Groins	1
198 Dock Non-Flow-Through		# of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1978 County: Brown

Township, Village or City name: Town of Green Bay PLSS section data sheets <u>included in summary</u> (give full

description):

T25N R22E SEC 13 SEC 14

SEC 15

SEC 22

LAND USE CATEGORIES

Control of the Contro	The state of the s	The same of the sa	Ar	'ea
		# of structures	Acres	<u> Hectares</u>
11 Residential			•	••
	المرابع والمساورة	to solve the sol		* *
111 Res. units	-		-	
garages sheds				
112 Res. units				
garages				
sheds				
113 Res. units		180	83	34
garages		58		
sheds barns		62		
115 Res. units		•		
garages				
sheds				
	Subtotal	304	83	34
12 Commonaini				
12 Commercial	٠.			
121 Central Bus:	iness Dist		6	2
122 Shopping Cer	nter/Mall _			
124 Neighborhood	d Business	Dist		
126 Institution				
The second secon	Subtotal	9	6	2
13 Industrial	رياني مملأ مريسيا	e en e	•	
THANSOT TOT	to the state of th			•
138 Industrial	Park	u tari		

Area

	# of structures	Acres 1	<u>lectares</u>
14 Transportation			
141 Die Messensetsties	•		
141 Air Transportation			
142 Rail Transportation	3		
143 Water Transportation			
143.1 Private Marina			
143.2 Public Boat Landing	3		
144 Highways 145 Communications			
146 Utilities			
146 Utilities 147 Sewage Treatment Plan			
147 Sewage Treatment Plan 148 Landfill	nt		
Subtotal			2
Subtotal	2	5	2
17 Extractive			
I/ EXCLUCIVE			
171 Open Pit			
172 Underground			
172 Underground	· · · · · · · · · · · · · · · · · · ·		
179 Other Extractive	:		
Cashd	total		······································
	COCAT		
18 Agricultural and Natural	1		
to uditorizates and nacuta.	4		
181 AF Abandoned Field _		Q	3
182 AG Agriculture Active	3	93	38
			53
184 H Heath 185 OW Open Water		2	1
186 RL Rock Ledge			
187 SL Slump Zone			
100 WT Wetland		9	4
188 WT Wetland Subtotal	The same of same to the same of the same o	242	98
Jubiotal Subcotal	The second transfer of the Mills paperion of	446	30
19 Open Land, Other	AND	~4	
19 Open panu, Other	en e		
191 Outdoor-Public Assemb		•	
	O1y	<u> </u>	1
192 Urban Open Lots	6	57	23
194 Cemeteries		3/	
Subtotal	6	58	24
Subcocal	•	36	24
	ma	tal Acres	. 394
₩		tal Hectares	
•	10	cal nectares	159
Shoreline Modifications		Linea	· •
SHOLETTHE MODILICACIONS			
195 Sea Walls		<u>Feet</u> 7369	<u>Meters</u>
444 Daniel Land		1351	2247
			412
197 Groins	-	# of Groins	
198 Dock Non-Flow-Through		# of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Brown

Township, Village or City name: Town of Green Bay PLSS section data sheets <u>included in summary</u> (give full

description):

T25N R22E SEC 13 SEC 14 SEC 15 SEC 22

LAND USE CATEGORIES

			Ar	ea
		# of structures	Acres	<u>Hectares</u>
11 Residential				
111 Res. units garages sheds				
112 Res. units garages sheds				
113 Res. units		177	86	35
garages sheds		<u>55</u> 66		
barns		<u>00</u> 5		
115 Res. units				
garages sheds				
	Subtotal	303	86	35
12 Commercial				
121 Central Bus		6	4	2
122 Shopping Ce	nter/Mall _	- · · · · · · · · · · · · · · · · · · ·		
124 Neighborhoo	a Business	Dist3	<u>1</u>	<u>1</u> 1
126 Institution	Subtotal			3
13 Industrial				
138 Industrial	Park			

	Total Hectar	es 148
Shoreline Modifications		near
	Feet	Meters
195 Sea Walls	7068	2155
196 Revetments	1019	311
197 Groins	# of Groins	s 1
198 Dock Non-Flow-Through	# of Docks	

14 Transportation

144 Highways

146 Utilities

148 Landfill

171 Open Pit

183 F Forest

188 WT Wetland

19 Open Land, Other

194 Cemeteries

184 H Heath

17 Extractive

173 Well

Subtotal

Subtotal

Civil Jurisdiction Summary Data Sheet

Year: 1978 County: Brown

Township, Village or City name: Village of Howard PLSS section data sheets <u>included in summary</u> (give full

description):

T24N R20E SEC 1

SEC 2

SEC 11

SEC 14

LAND USE CATEGORIES

والمراجع والمراجع والمراجع والمراجع والمعارض والمنافض والمنافض والمناف والمراجع والمراجع والمراجع والمراجع والمراجع Area # of structures Acres Hectares The second secon 11 Residential - 111 Res. units _____ garages sheds 112 Res. units garages_ sheds garages ____11 32 sheds barns 115 Res. units -- garages sheds Subtotal 80 27 11 12 Commercial 121 Central Business Dist ____ 122 Shopping Center/Mall ____ 124 Neighborhood Business Dist _____ 126 Institutional Subtotal 13 Industrial 138 Industrial Park

Area

of structures Acres Hectares

		F of Structur	es <u>Acres</u>	nectar
14 Transpo	ortation			
949 340	Muananeutaties			
141 A1F	Transportation			
142 Rail	Transportation			
143 Wate	er Transportation _			·
143.1 Pr	r Transportation	·		
143.2 PU	ibile Roat Paudind			
144 High	ways			
145 Com	nunications			
146 Util	ities			
147 Sewa	lities nge Treatment Plant			
148 Land	fill			
200 2000	Subtotal			·
17 Extract	ive			
171 Oper				
	erground	·		
173 Well				
179 Othe	r Extractive			
	Subto	tal		
1				
18 Agricul	tural and Natural	·		-
181 AF A	bandoned Field		1	<1
182 AG A	griculture Active		2	1
193 F F	orest		<u>~</u>	
103 F F	leath	· · · · · · · · · · · · · · · · · · ·		
105 00 0	pen Water		28	12
105 ON C	pen water		48	
103 CT C	lock Ledge			
18/ SL S	Slump Zone			
188 WT W	etland		319	129
en concrete a service	Subtotal	and the second second	352	143

19 Open La	ind, Other	4-04		
	•			
191 Outd	loor-Public Assembl	у		
192 Urba		4	5	2
	loor Recreation		2	1
194 Ceme				
	Subtotal	4	6	2
****			Total Acres	386
			Total Hectares	156
···	7:0: .:	•		
<u>Shoreline</u>	<u>Modifications</u>		Line	
		t	<u>Feet</u>	Meter
195 Sea			219	6.7
196 Reve	tments		156	
197 Groi	.ns		# of Groins	
	Non-Flow-Through		# of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Brown

Township, Village or City name: Village of Howard PLSS section data sheets <u>included in summary</u> (give full

description):

T24N R20E SEC 1 SEC 2 SEC 11 SEC 14

LAND USE CATEGORIES

Area # of structures Acres Hectares 11 Residential 111 Res. units garages sheds 112 Res. units garages sheds 39 29 12 113 Res. units garages 10 sheds 22 barns 115 Res. units garages sheds Subtotal 71 29 12 Commercial 121 Central Business Dist _____ 122 Shopping Center/Mall _ 124 Neighborhood Business Dist _ 126 Institutional Subtotal 13 Industrial 138 Industrial Park _____

		Area	
	# of structures	Acres H	ectares
	<u> </u>		<u> </u>
14 Transportation			
	•		
141 Air Transportation			
142 Rail Transportation _			
143 Water Transportation			
143.1 Private Marina			
143.2 Public Boat Landing			
144 Highways 145 Communications			
145 Communications			
146 Utilities			
146 Utilities 147 Sewage Treatment Plan	t		
148 Landfill			
Subtotal			
4 P. Washing out Land			
17 Extractive			
171 Owen Dib			
171 Open Pit			
172 Underground			
179 Other Extractive			
Subto	otal		
18 Agricultural and Natural			
10 AGIICUICUIAI ANG NACUIAI			
181 AF Abandoned Field		3	1
182 AG Agriculture Active			<1
			18
104 W Weeth			
185 OW Open Water		20	8
186 RL Rock Ledge			
187 SL Slump Zone		····	.,
188 WT Wetland		285	115
Subtotal		352	143
Subcocal		332	143
19 Open Land, Other			
13 Open Bana, Other			
191 Outdoor-Public Assemb	lv		
192 Urban Open Lots	2	10	<u> </u>
193 Outdoor Recreation			 -
194 Cemeteries			
Subtotal	2	10	4
	_		•
	Tot	tal Acres	391
		tal Hectares	158
		·	
Shoreline Modifications		Linea	r
		Feet	<u>Meters</u>
195 Sea Walls		34	1.0
196 Revetments		996	304
197 Groins		f of Groins	
198 Dock Non-Flow-Through		of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1978 County: Brown Township, Village PLSS section data description):	or City namesheets <u>incl</u>	e: Town of Scot uded in summary	t (give full	L
T24N R21E SE		T25N R22E SEC 2		
	C 2	SEC 2		
T24N R22E SE		SEC 2		
T25N R21E SE	C 36	SEC 2 SEC 3		
		SEC 3		
· · · · · · · · · · · · · · · · · · ·				
A service of the serv	LAND U	SE CATEGORIES		
The contract of the contract o	to employers all			rea
		f of structures	Acres	<u> Hectares</u>
11 Residential	** **	· · · · · · · · · · · · · · · · · · ·		a de la companya de
111 Res. units garages				
sheds	·			
112 Res. units garages				
sheds				
113 Res. units	·	294	151	61
garages		99		
sheds		117		
barns		16		
115 Res. units				
garages sheds				
sneus	Subtotal	526	. 151	61
12 Commercial		,		
121 Central Bus	iness Dist _			
122 Shopping Ce			1	1
124 Neighborhoo		ist <u>9</u>	44	22
126 Institution				
•	Subtotal	9	5	2
13 Industrial	* * * * * * * * * * * * * * * * * * * *			
138 Industrial	Park			

Area

	# of structures	Acres 1	<u>iectares</u>
14 Transportation			
141 Air Transportation 142 Rail Transportation 143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plan	J		
148 LandfillSubtotal			
17 Extractive			
172 Underground			
18 Agricultural and Natural	Land Control		
181 AF Abandoned Field		68	2 113 28
185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland		32	13
Subtotal 19 Open Land, Other	and the second s	571	231
191 Outdoor-Public Assemb	oly		
192 Urban Open Lots 193 Outdoor Recreation 194 Cemeteries		5	
Subtotal		5	2
		al Acres al Hectares	732 296
Shoreline Modifications		Linea Feet	ar <u>Meters</u>
100 December		5108 6428	1557 1960
198 Dock Non-Flow-Through		of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Brown Township, Village PLSS section data description):	or City na sheets <u>inc</u>	ame: Town of Scot cluded in summary	t (give full	L
T24N R21E SE SE T24N R22E SE T25N R21E SE	C 2 C 6	T25N R22E SEC 20 SEC 20 SEC 20 SEC 20 SEC 30 SEC 30	1 8 9 0	
•	LAND	USE CATEGORIES		
				ea
		# of structures	Acres	<u> Hectares</u>
11 Residential				
111 Res. units garages sheds				
garages sheds				
113 Res. units garages sheds		264 90 76	145	59
barns 115 Res. units garages sheds		5		
Sileus	Subtotal	435	145	59
12 Commercial				
121 Central Bus 122 Shopping Ce 124 Neighborhoo 126 Institution	nter/Mall _. d Business	Distl		
13 Industrial				
138 Industrial	Park	10	6	2

of structures

	F OI SCIUCTURES	Vertes 1	ectares
14 Transportation			
a da a sa			
141 Air Transportation	· · · · · · · · · · · · · · · · · · ·		
142 Rail Transportation			
143 Water Transportation			
143.1 Private Marina	· · · · · · · · · · · · · · · · · · ·		<u></u>
143.2 Public Boat Landing			
144 Highways 145 Communications		······································	
146 Utilities			
146 Utilities 147 Sewage Treatment Plant		<u> </u>	
148 Landfill		-	
Subtotal		<1	<1
17 Extractive			
171 Open Pit			
172 Underground			
173 Well			
179 Other Extractive			
179 Other ExtractiveSubtot	tal		
18 Agricultural and Natural			-
181 AF Abandoned Field		84	34
182 AG Agriculture Active _		260	105
183 F Forest		173	70
184 H Heath	· · · · · · · · · · · · · · · · · · ·	3	1
185 OW Open Water		33	13
186 RL Rock Ledge			
187 SL Slump Zone			
188 WT Wetland Subtotal		63	25
Subtotal		616	249
19 Open Land, Other			
191 Outdoor-Public Assembly	<i></i>		
192 Urban Open Lots			
193 Outdoor Recreation		7	3
194 Cemeteries		-	
Subtotal		7	3
	Tot	al Acres	77:3
		al Hectares	313
Shoreline Modifications		Linea	r
		<u>Feet</u>	Meters
195 Sea Walls		6197	1889
196 Revetments		5927	1807
197 Groins	#		
198 Dock Non-Flow-Through	#	of Docks	

Civil Jurisdiction Summary Data Sheet

LAND USE CATEGORIES Area # of structures Acres 11 Residential 111 Res. units garages sheds 112 Res. units garages sheds	
# of structures Acres 11 Residential 111 Res. units garages sheds 112 Res. units garages sheds sheds sheds	
# of structures Acres 11 Residential 111 Res. units - garages sheds 112 Res. units garages sheds sheds sheds	a Hectares
# of structures Acres 11 Residential 111 Res. units garages sheds 112 Res. units garages sheds sheds	
11 Residential 111 Res. units garages sheds 112 Res. units garages sheds sheds	<u>Hectares</u>
111 Res. units garages sheds 112 Res. units garages sheds	
garages sheds 112 Res. units garages sheds	
sheds 112 Res. units garages sheds	
112 Res. units garages sheds	
sheds	
113 Kes. Units - 126 94	
garages57	38
sheds 85	
barns 2	
115 Res. units	
garagessheds	
Subtotal 300 93	38
12 Central Business Dist 121 Central Business Dist 122 Shopping Center/Mall 124 Neighborhood Business Dist 126 Institutional	
Subtotal	
- 13 Industrial	

----- 138 Industrial Park _____

	# of structure	es Acres	<u>lectares</u>
14 Transportation			
141 Air Transportation 142 Rail Transportation			
142 Rail Transportation _			
143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing			
143.1 Private Marina	6	5	2
143.2 Public Boat Landing		<1	<1
144 Highways			
145 Communications			
144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant	11	4	2
147 Sewage Treatment Plant			
148 Landfill			
Subtotal	17	10	4
17 Extractive			
171 Open Pit			
172 Underground			
173 Well 179 Other Extractive		·	
179 Other Extractive			
Subto	otal		
property and the second	· · · · · · · · · · · · · · · · · · ·		
18 Agricultural and Natural	* **		
181 AF Abandoned Field			
182 AG Agriculture Active		43	18
103 r rolesc			10
184 H Heath 185 OW Open Water		4	2
185 OW Open Water		50	2.0
186 RL Rock Ledge			
10 \ 21 21 mb 2016			
188 WT Wetland		761	308
188 WT Wetland Subtotal		882	357
	• • •	· ·	
19 Open Land, Other	• • • • • • • • • • • • • • • • • • • •		
		•	
191 Outdoor-Public Assemb	lv	* · · · · · · · · · · · · · · · · · · ·	
192 Urban Open Lots	1	3	1
193 Outdoor Recreation	Blooming and the state of the s		·····
194 Cemeteries			
Subtotal	1	3	1
	-		=
		Total Acres	988
**		Total Hectares	400
		Hencares	400
Shoreline Modifications		Linea	ar
PHOTETTHE MOUTITE TOUTE	• .	Feet	Meters
195 Sea Walls		2794	
			<u>852</u>
196 Revetments		16892	<u>5150</u>
197 Groins	~ · · · · · · · · · · · · · · · · · · ·	# of Groins	
198 Dock Non-Flow-Through		# of Docks	

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Brown Township, Village PLSS section data description):	or City na sheets <u>inc</u>	nme: Town o cluded in su	of Suamic mmary (g	o rive full	
SEC	2 13 2 24 2 25 2 36	T25N R21E	SEC 5 SEC 6 SEC 7 SEC 8 SEC 18 SEC 19		
	LAND	USE CATEGOR	RIES		
_		# of struc	tures	Are Acres	
11 Residential					
111 Res. units garages sheds 112 Res. units garages					
sheds 113 Res. units		145		69	28
garages	•	45			
sheds		49 2			
barns 115 Res. units					
garages sheds					
Sileds	Subtotal	241		69	28.
12 Commercial					
121 Central Busi 122 Shopping Cer 124 Neighborhood 126 Institutions	nter/Mall _ l Business	Dist			
	Dubeccal	-			
13 Industrial					

138 Industrial Park 1 4

Area Acres Hectares

of structures

	# of structures	<u>Acres</u>	<u>Hectares</u>
14 Transportation			
141 Air Transportation			
143 Water Transportation	<u> </u>		
143.1 Private Marina	4	8	3
143.2 Public Boat Landing		<1	<1
144 Highways	3	2	1
145 Communications			
146 Utilities			
147 Sewage Treatment Plant			
148 Landfill			
Subtotal	7	9	4
17 Extractive			
171 Amon Dit			
171 Open Pit 172 Underground			
173 Well			
179 Other Extractive	L . 3		
Subto	tal		
18 Agricultural and Natural			
101 10 111 71-13		1.0	-
181 AF Abandoned Field		16	
182 AG Agriculture Active		_	15
183 F Forest		56	23
184 H Heath 185 OW Open Water		9	4
185 OW Open Water		36	<u> 15</u>
TOO KU KOCK DECOE			
187 SL Slump Zone 188 WT Wetland Subtotal		 	
188 WT Wetland		<u>557</u>	226
Subtotal		711	288
19 Open Land, Other			
191 Outdoor-Public Assembl	у		
192 Urban Open Lots		3	1
193 Outdoor Recreation			
194 Cemeteries		•	
Subtotal		3	1
		Cotal Acres	797
,	2	Total Hectares	323
Shoreline Modifications		Line	
		<u>Feet</u>	<u> Meters</u>
	······································	2413	736
196 Revetments		14337	4371
197 Groins		# of Groins	
198 Dock Non-Flow-Through		# of Docks	